MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 2, 2022/2023**

## BTS3014 –TIME SERIES ANALYSIS AND FORECASTING

( All sections / Groups )

3 JULY 2023
2.30 p.m. – 4.30 p.m.
( 2 Hours )

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**INSTRUCTIONS TO STUDENTS**

1. This question paper consists of **FOUR (4)** questions in **SIX (6)** printed pages, including formula sheet and statistical tables.

2. Answer **ALL** questions in the answer booklet provided.

3. Marks are shown at the end of each question.

## Question 1

**Table 1** below presents the data of Malaysian Gross Domestic Product (GDP) per capita growth from 2010 to 2018.

**Table 1**

| Year | GDP per capita growth (annual %) |
|---|---|
| 2010 | 5.6 |
| 2011 | 3.6 |
| 2012 | 3.8 |
| 2013 | 3.0 |
| 2014 | 4.4 |
| 2015 | 3.5 |
| 2016 | 2.9 |
| 2017 | 4.3 |
| 2018 | 3.5 |

Source: Data are obtained from World Bank, www.databank.worldbank.org.

(a) Based on the data above, produce the GDP per capita growth forecast from 2013 to 2018 using the following forecasting method:

(i) Moving average of 2, MA (2) (6 marks)

(ii) Simple exponential smoothing (assume $\alpha = 0.6$, initial value = 4.0) (6 marks)

[*Hint: Students are required to produce TWO separate tables to show the forecast results of MA and SES in the answer booklet. Please ensure that all the computations are accurate to* ***three decimal places***]

(b) Compute the mean absolute error (MAE) and mean squared error (MSE) for each forecasting method in part (a). (9 marks)

(c) Based on your answer in part (b), assess which forecasting method performs better. Produce the one-period-ahead forecast for the GDP per capita growth in 2019 using your suggested method. (4 marks)

**[Total: 25 marks]**

**Continued...**

## Question 2

Consider the following multiple regression model for Malaysia from the period of 1998Q1 to 2018Q3:

$$RGDP = \beta_0 + \beta_1 EX + \beta_2 KLCI + \beta_3 IR + \mu \quad \ldots (2.1)$$

| | | |
|---|---|---|
| *RGDP* | : | Real GDP in natural log |
| *EX* | : | Exchange rate |
| *KLCI* | : | Kuala Lumpur Composite Index in natural log |
| *IR* | : | Interest rate |

The results are reported in **Table 2.1**.

**Table 2.1**

Sample: 1999Q1 to 2019Q3
Included observations: 83

| Variable | Coefficient | Standard error | t-statistics | Probability |
|---|---|---|---|---|
| Constant | 12.235 | 0.550 | 22.245 | 0.000 |
| *EX* | -2.152 | 0.105 | -20.495 | 0.000 |
| *KLCI* | 0.526 | 0.094 | 5.596 | 0.000 |
| *IR* | -0.142 | 0.017 | -8.353 | 0.000 |

$R$-squared = 0.989
$F$-statistic = 53.140 [*p-value*: 0.000]
Jarque-Bera test = 0.764 [*p-value*: 0.682]
Serial correlation LM test = 5.477 [*p-value*: 0.445]
White test = 25.967 [*p-value*: 0.135]

**Table 2.2: Correlation Matrix**

| | *EX* | *KLCI* | *IR* |
|---|---|---|---|
| *EX* | 1 | --- | --- |
| *KLCI* | -0.160 | 1 | --- |
| *IR* | 0.366 | -0.236 | 1 |

Based on **Tables 2.1** and **2.2**, answer the following questions:

(a) Interpret the estimated coefficient for the variable of *KLCI*. (3 marks)

(b) Interpret the coefficient of determination. (3 marks)

(c) Do *EX*, *KLCI* and *IR* significantly explain *RGDP* in Malaysia? Assess it using $F$-test at $\alpha = 1\%$. (6 marks)

(d) Has the estimated multiple regression model met the **FOUR (4)** assumptions underlying the method of Ordinary Least Square (OLS)? Interpret your answer based on $\alpha = 5\%$. (6 marks)

**Continued...**

(e) Produce a 95% prediction interval for the Real GDP in natural log, given $EX$ = 4.541, $KLCI$ = 7.252, $IR$ = 2.75, and the estimated standard error = 0.1261.

(7 marks)

**[Total marks: 25 marks]**

## Question 3

Table 3 presents the hypothetical data for sales volume in ACE Company.

**Table 3**

| Time | t | Sales [Y] | MA(4) | CM(4) | Detrended series |
|---|---|---|---|---|---|
| 2020Q1 | 1 | 50 | --- | --- | --- |
| 2020Q2 | 2 | 70 | --- | --- | --- |
| 2020Q3 | 3 | 80 | 80 | | |
| 2020Q4 | 4 | 120 | | | |
| 2021Q1 | 5 | 155 | | | |
| 2021Q2 | 6 | 125 | | | |
| 2021Q3 | 7 | 105 | | | |
| 2021Q4 | 8 | 240 | | | |
| 2022Q1 | 9 | 170 | | | |
| 2022Q2 | 10 | 150 | | | |
| 2022Q3 | 11 | 165 | --- | --- | --- |
| 2022Q4 | 12 | 265 | --- | --- | --- |

**Continued...**

**Table 4: Seasonal calculations**

| Quarter | 2020 | 2021 | 2022 | Seasonal means | Adjusted means |
|---|---|---|---|---|---|
| Q1 | --- | | | | |
| Q2 | --- | | | | |
| Q3 | | | --- | | |
| Q4 | | | --- | | |
| | | | **Total** | | |

(a) Compute the seasonal factors using classical multiplicative decomposition method. (16 marks)

[*Hint: Students are required to reproduce Table 3 and Table 4 in the answer booklet. All the computations are to be rounded up to* ***three decimal places***]

(b) Assuming the trend in the data is $T_t = 51.404 + 13.794t$, where $t$ =1 is 2020Q1 and $t$ = 12 is 2022Q4. Compute the trend from 2020Q1 to 2022Q4. (6 marks)

[*Please ensure that all the computations are accurate to* ***three decimal places****]*

(c) Produce the company's quarterly sales volume forecast for 2023 Q1. (3 marks)

**[Total marks: 25 marks]**

**Question 4**

(a) Demonstrate the **FOUR (4)** steps involved in the application of a suitable ARIMA model to short-term forecasting on share price. (12 marks)

(b) Show the difference between judgemental forecasting and quantitative forecasting. (4 marks)

(c) Interpret the **THREE (3)** types of data available for quantitative forecasting. (6 marks)

(d) Present any **TWO (2)** reasons for over-reliance on judgemental approaches by many organisations in the process of forecasting. (3 marks)

**[Total marks: 25 marks]**

**End of Questions**

**Formula Sheet**

Simple exponential smoothing (SES):

$$\hat{Y}_{t+1} = \alpha Y_t + (1-\alpha)\hat{Y}_t$$

Linear exponential smoothing (LES):

$$L_t = \alpha Y_t + (1-\alpha)(L_{t-1} + T_{t-1})$$

$$T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$$

$$\hat{Y}_{t+p} = L_t + pT_t$$

Moving Average:

$$\hat{Y}_{t+1} = \frac{Y_t + Y_{t-1} + \ldots + Y_{t-K+1}}{K}$$

Double Moving Average:

$$\hat{Y}_{t+p} = a_t + b_t p$$

$$a_t = 2M_t - M'_t$$

$$b_t = \frac{2}{K-1}(M_t - M'_t)$$

Mean Absolute Error (MAE) $= \frac{1}{n}\sum_{i=1}^{n}|Y_{t+i} - F_{t+i}|$

Mean Square Error (MSE) $= \frac{1}{n}\sum_{i=1}^{n}(Y_{t+i} - F_{t+i})^2$

Root Mean Square Error (RMSE) $= \sqrt{MSE}$

$$Elasticity = b_1\left(\frac{X}{Y}\right)$$

Time series additive decomposition

$$Y_t = T_t + C_t + S_t + \varepsilon_t$$

Time series multiplicative decomposition

$$Y_t = T_t * C_t * S_t * \varepsilon_t$$

AR process: $p$-order autoregressive model

$$Y_t = \gamma_0 + \gamma_1 Y_{t-1} + \gamma_2 Y_{t-2} + ... + \gamma_p Y_{t-p} + \varepsilon_t$$

MA process: $q$-order moving average model

$$Y_t = \theta_0 + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - ... - \theta_q \varepsilon_{t-q}$$

Regression model:

$$t - statistic = \frac{\hat{\beta} - \beta}{se(\hat{\beta})}$$

Prediction interval = $F_{t+1} \pm (t_{\alpha/2, n-K-1}) * SE$

Summary of $t$-distribution:

| **df \ Pr** | **0.05**<br>**0.10** | **0.025**<br>**0.05** | **0.005**<br>**0.010** |
|---|---|---|---|
| 40 | 1.684 | 2.021 | 2.704 |
| 60 | 1.671 | 2.000 | 2.660 |
| 120 | 1.658 | 1.890 | 2.617 |
| ∞ | 1.645 | 1.960 | 2.576 |

**End of Paper**